Title: Study of ultrafine-grained materials prepared with different methods of severe plastic deformation

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Abstract: Interstitial free steel with ultrafine-grained (UFG) structure was prepared by high-pressure torsion (HPT). The development of the microstructure as a function of the number of HPT turns was studied at the centre, half-radius and periphery of the HPT-processed disks by X-ray line profile analysis (XLPA), positron annihilation spectroscopy (PAS) and electron microscopy. The dislocation densities and the dislocation cell sizes determined by XLPA were found to be in good agreement with those obtained by PAS. The evolution of the dislocation density, the dislocation cell and grain sizes, the vacancy cluster size, as well as the high-angle grain boundary (HAGB) fraction was determined as a function of the equivalent strain. It was found that first the dislocation density saturated, then the dislocation cell size reached its minimum value and finally the grain size got saturated. For very high strains after the saturation of grain size the HAGB fraction further increased. The PAS investigations revealed that vacancies introduced by severe plastic deformation agglomerated into small clusters consisting of 9-14 vacancies. The evolution of the yield strength calculated from the microhardness as a function of strain was explained by the development of the defect structure.

In the second part of this work the creep-resistant AX41 magnesium alloy (Mg-4 wt.% Al-1 wt.% Ca) was processed by method of Equal Channel Angular Pressing (ECAP) up to total of eight passes. The impact of various deformation routes (*A*, B_c and *C*), temperature of processing (220 °C and 250 °C) and the initial grain size (10 μm, 190 μm) on the microstructural evaluation and mechanical properties was studied. Microstructural features were characterized by means of light microscopy, electron back-scattering and X-ray diffraction methods. Mechanical properties were investigated in tension at a constant strain rate of 10^{-4} s^{-1} in the temperature range of 20-300 °C and by Vickers microhardness testing. Significant grain refinement was observed for all processing conditions. It has been found that

average grain size, fraction of the HAGB, dislocation density and texture significantly depends on the number of passes and the experimental parameters of ECAP processing. A model describing the formation of texture during processing through different ECAP routes was proposed. Route *A* was found to be the most effective processing route from the point of view of grain size refinement and the room temperature strength after 8 passes. The influence of the average grain size, the texture and the dislocation structure on the yield strength at room temperature is discussed in detail.

Keywords: interstitial free steel; AX41 magnesium alloy; ultrafine-grained materials; severe plastic deformation; positron annihilation; X-ray diffraction; EBSD